# Chapter 9 Tunnels

## 9-1 General

The National Tunnel Inspection Standards (NTIS) are published in the Code of Federal Regulations, 23 CFR 650, Subpart E. The NTIS requires that tunnel owners establish a program for the inspection of highway tunnels, to maintain a tunnel inventory, to report the inspection findings to FHWA, and to correct any critical findings found during these inspections. The Washington State's tunnel inspection program functions fully within the umbrella of the Washington State's bridge inspection organization.

Washington State's tunnel inspection organization, however, is only responsible for state and local agency-owned tunnels. Federally-owned tunnels are inventoried, inspected, and managed by federal agencies. Privately-owned highway tunnels are not included in this requirement, although WSDOT encourages private tunnel owners to inspect and maintain their tunnels in conformance with the NTIS and this manual. There is an open invitation for private tunnel owners to submit bridge records to the Washington State Bridge Inventory System (WSBIS).

### 9-1.1 *Definitions*

**Complex Tunnel** – A tunnel characterized by advanced or unique structural elements or functional systems.

**Highway LID** – A structure built with green space which interconnects neighborhoods otherwise cut off or impacted by freeways, with or without local roads. If carrying local roads, the structure must have a deck area at least twice the area of the roads it carries. Highway "LIDS" shall be inventoried as tunnels under the NTIS.

**National Tunnel Inspection Standards (NTIS)** – Title 23 Code of Federal Regulations 650 Subpart E defines the NTIS regulations, and establishes requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a state tunnel inventory. The NTIS apply to all structures defined as highway tunnels located on all public roads.

**Tunnel** – The term ''tunnel'' means an enclosed roadway for motor vehicle traffic with vehicle access limited to portals, regardless of type of structure or method of construction, that requires, based on the owner's determination, special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity. The term ''tunnel'' does not include bridges or culverts inspected under the National Bridge Inspection Standards (Title 23 Code of Federal Regulations 650 Subpart C). The state of Washington shall prepare and maintain an inventory of all tunnels subject to the NTIS.

**Specifications for the National Tunnel Inventory (SNTI)** – The SNTI is intended to supplement the NTIS and provide the specifications for coding data required to be submitted to the National Tunnel Inventory (NTI). Data in the NTI will be used to meet legislative reporting requirements and provide tunnel owners, the Federal Highway Administration (FHWA) and the general public with information on the number and condition of the Nation's tunnels.

**National Tunnel Inventory (NTI)** – The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Tunnel Inspection Standards.

**Tunnel Operations, Maintenance, Inspection, and Evaluation Manual (TOMIE)** – The TOMIE provides uniform and consistent guidance on the operation, maintenance, inspection, and evaluation of tunnels.

See Section 1-1.1 for additional definitions used in this manual.

## 9-2 Description of Tunnel Inspection Organization

In accordance with the description of the Bridge Inspection Organization offered in Section 1-2, a tunnel inspection organization as required by the NTIS has been developed. The tunnel inspection organization functions completely under the umbrella of the Washington State bridge inspection organization. The makeup of the tunnel organization is identical in all aspects as the bridge inspection organization.

## 9-3 Tunnel Inspection Programs

In accordance with the description of the Bridge Inspection Programs offered in Section 1-3, a tunnel inspection program as required by the NTIS has been developed. The tunnel inspection program functions completely under the umbrella of the Washington State bridge inspection organization. The makeup of the tunnel inspection program is identical in all aspects as the bridge inspection program.

## 9-4 Tunnel Inspection Organization Roles and Responsibilities

In accordance with the description of the Bridge Inspection Organization Roles and Responsibilities offered in Section 1-4, tunnel inspection Organization Roles and Responsibilities as required by the NTIS has been developed. Tunnel inspection roles and responsibilities fall completely under the umbrella of the Washington State bridge inspection organization with the additional requirement for the Team Leader as described below.

### 9-4.1 *Team Leader (TL)*

A team leader is in charge of an inspection team and responsible for planning, preparing, and performing the field inspection of tunnels. The team leader also makes repair recommendations and is responsible for initiating the critical damage procedures including full tunnel closure if deemed necessary. To qualify as a team leader, the individual must meet, at a minimum, the team leader requirements as described in the NTIS. Team leaders must be recertified on a regular basis by attending a refresher training class according to federal policy. The certification process is described in detail in Section 1-5.

## 9-5 Tunnel Inspection Certification

Certification for tunnel inspection work within the state of Washington is in accordance with the requirements described in Section 1-5 with the additional requirement of having a Certificate of completion of an FHWA approved comprehensive tunnel inspection course such as the NHI Tunnel Safety Inspection course.

## 9-6 Tunnel Inspection Certification Probation, Suspension, Decertification and Reinstatement

A process for decertification has been established to ensure that all PM's and TL's are following the proper conduct of their respective positions. The requirements for Tunnel inspectors is identical to that of Bridge Inspectors as described in Section 1-6.

## 9-7 Inspections

A multi-disciplined approach to tunnel inspection has been adopted by the WSDOT Bridge Preservation Office to comply with the requirements of the NTIS. Routine inspections for the Civil and Structural components are described in Chapter 3 while the Electrical and Mechanical inspection are described in Chapter 8.

## 9-8 Tunnel Elements

BMS elements for WSDOT Tunnels is listed in Appendix 9-A (Only Civil/Structural Elements)

*There is no translation from WSDOT condition state to the SNTI.

WSDOT Pre-NTIS tunnel elements 250, 251, 252, 253 are discontinued and replaced with the Specifications for the National Tunnel Inventory (SNTI) elements. WSDOT bridge elements previously included in tunnel inspections no longer apply to tunnels.

This section describes why modified tunnel condition states are used by WSDOT to manage and inspect the tunnels. Element names and numbers are the same as published in the Specifications for the National Tunnel Inventory (SNTI), with WSDOT minor clarifications to the descriptions. However, the condition state definitions have been modified to follow the management and inspection philosophies of the WSDOT Bridge Elements as described here, see Section 4-1.3.A for the use of the word "Affected" in evaluating condition states. There are no clarifications or changes to the Tunnel Inventory items.

The WSDOT deviation in condition evaluation can be summarized by stating the Condition State 2 (CS2) is reserved to document the quantity of repairs only, and excludes minor deteriorations that are not significant to management or the condition evaluation. The SNTI sets the precedent to evaluate repairs as a condition state 2 and has several examples specified, such as: Patching, Sound Patching, Arrested Cracks, Doubling Plates or similar, and other "Mitigated Defects". By including conditions other than repairs, the SNTI evaluation is more difficult and dilutes the quality of data for management purposes. This WSDOT CS2 deviation from SNTI is small, but has a large impact to the inspector and a significant improvement to the asset management.

The SNTI condition states require the inspector to make three evaluations to determine the proper condition state; typically, "Is the field condition CS2? or CS3?, or CS4? This requires significant memorization of the element definitions to consistently and correctly evaluate a variety of material defects, and extrapolate for defects not specified. By documenting only repair quantities in CS2, the inspector evaluation is essentially reduced to, "Is the defect CS3 or CS4?" The evaluation is focused on the important field conditions and the most valuable to management where the following significant benefits and efficiencies are realized.

1. The coding is simplified since repairs are easily identified and quantified. This improves the consistency between inspectors and is quality improvement because CS3 and CS4 is the focus of the inspection effort which provides the most useful data to predict future conditions and budgeting need. The focus is on, "What needs to be inspected and documented?"

2. More efficient in two ways. The first saves time because a large number of CS2 minor structural defects are ignored, such as: Freckled rust, Discoloration, Beginning Decay, and Hairline cracks. This data and documentation is not useful for prediction of element deterioration and does not justify the attention of funding. The second efficiency is a small number defects specified in SNTI as CS2 may be evaluated as WSDOT CS3, such as "Loose Fasteners in a Steel Tunnel Liner" because a repair may be appropriate. This useful information is more appropriate to WSDOT as CS3.

3. Pre-defined condition states for a few defects can create coding problems and are replaced with a more practical and useful evaluation. For example, the width of a concrete crack determines the SNTI condition state where large cracks are CS4. This prescriptive coding assumes a small crack is not a problem which may not be the case in the field. WSDOT condition state 3 and 4 is based on the importance of the crack using engineering judgment and practice, where the crack width is a factor. This allows a structurally significant small crack to be CS3 OR CS4 and a large crack ¼" wide in a sidewalk/barrier could be CS1. This WSDOT philosophy solves the coding problem for all materials including pre-cracked timber and concrete.

4. Repair quantities exclusively in CS2 provide the benefit of indirectly tracking a long term cost and decline of the asset. As the quantities change with time, CS1 quantities move to 3 or 4 and collect as expensive CS2 repairs. The SNTI definition eventually leads to a problem on older elements when the history of repairs is mixed with minor element defects because two possible conditions can exist with a large amount of CS2. Either an element is aging gracefully or the element has frequently been in Poor condition with a large amount of repairs; or some combination thereof. These are two different and distinct scenarios that cannot be distinguished in SNTI data for modeling or funding. By having exclusive CS2 repair quantities, WSDOT can model both scenarios. In addition, the CS2 quantities are an indicator of element performance and better of support the decision of when to replace the element in the inventory.

5. The WSDOT tunnel conditions tie directly to an NBI reporting of Good, Fair, and Poor which are directly associated with the established "Structurally Deficient" rating for bridges. Primary tunnel elements with quantities in CS3 are considered by WSDOT as Fair condition, and tunnels with quantities in CS4 are in Poor condition. If FHWA establishes an equivalent rating system for tunnels or WSDOT includes tunnels in reporting processes, the WSDOT elements have a justifiable reporting system.

   The SNTI use of the word "Severe" to describe CS4 has proven confusing to the WSDOT inspection and reporting process. Severe structural defects are viewed as something that demands an immediate or emergency action and inappropriate for a management system which takes up to 10 years or more to respond with funding.

There are two important goals behind any asset management system. One goal is to identify what may require funding in the future and the second goal is to identify what needs funding now. With repairs dedicated to CS2, WSDOT definitions directly support these two goals with field conditions in state 3 may require funding, but not at this time; and field conditions in state 4 require funding for repair, rehabilitation, or replacement of the element, but are still safe for public use. If CS2 is used to collect other field conditions, the two goals of asset management are diminished and with little benefit.

6. Lastly, WSDOT believes modified CS2 is technically within the intent of the SNTI CS2 since repairs are clearly specified for several SNTI elements. Therefore, the FHWA element reporting will reflect the data as coded by the WSDOT inspector.

## 9-9 Tunnel QC/QA Program

In accordance with the description of the WSDOT Bridge Preservation Office Quality Control Program offered in Section 7-2, a tunnel QC program as required by the NTIS has been developed. The tunnel inspection program functions completely under the umbrella of the Washington State bridge inspection organization. The makeup of the tunnel QC program is identical in all aspects as the bridge inspection QC program except for Mechanical and Electrical QC, which is developed and documented in Section 8-4.

## 9-10 Tunnel Records

### 9-10.1 *SNTI Coding Guide*

In accordance with the description of the WSDOT Bridge Preservation Office Bridge Files and Documentation offered in Section 2-1, Tunnel Files and Documentation as required by the NTIS has been developed. Tunnel Files and Documentation functions completely under the umbrella of the Washington State bridge inspection organization.

The SNTI Coding Guide Section 2 Inventory data has been incorporated into the WSBIS Coding Guide, available in Appendix 2-C. A summary of the SNTI codes with associated WSBIS codes are in Appendix 9-C.

## 9-11 Appendices

| | |
|---|---|
| Appendix 9-A | Civil/Structural Tunnel BMS Elements |
| Appendix 9-B | Vacant |
| Appendix 9-C | WSBIS / NTI Tunnel Inventory Codes |

# *Appendix 9-A Tunnel BMS Elements*

## Civil/Structural Tunnel BMS Element Listing

| Element Type | Element Number | Element Description | Unit | Page |
|---|---|---|---|---|
| Liners | 10000 | Steel Tunnel Liner | SF | 9-A-1 |
| | 10001 | Cast-In-Place Tunnel Liner | SF | 9-A-3 |
| | 10002 | Precast Concrete Tunnel Liner | SF | 9-A-3 |
| | 10003 | Shotcrete Tunnel Liner | SF | 9-A-3 |
| | 10004 | Timber Tunnel Liner | SF | 9-A-3 |
| | 10005 | Masonry Tunnel Liner | SF | 9-A-4 |
| | 10006 | Unlined Rock Tunnel | SF | 9-A-4 |
| | 10007 | Rock Bolt/Dowel | EA | 9-A-4 |
| | 10009 | Other Tunnel Liner | SF | 9-A-5 |
| Tunnel Roof Girders | 10010 | Steel Tunnel Roof Girders | LF | 9-A-5 |
| | 10011 | Concrete Tunnel Roof Girders | LF | 9-A-5 |
| | 10012 | Prestressed Concrete Tunnel Roof Girders | LF | 9-A-5 |
| | 10019 | Other Tunnel Roof Girders | LF | 9-A-5 |
| Columns / Piles | 10020 | Steel Column / Piles | EA | 9-A-6 |
| | 10021 | Concrete Column / Piles | EA | 9-A-6 |
| | 10029 | Other Column / Piles | EA | 9-A-6 |
| Cross Passageway | 10030 | Steel Cross Passageway | LF | 9-A-6 |
| | 10031 | Concrete Cross Passageway | LF | 9-A-6 |
| | 10033 | Shotcrete Cross Passageway | LF | 9-A-6 |
| | 10034 | Timber Cross Passageway | LF | 9-A-6 |
| | 10035 | Masonry Cross Passageway | LF | 9-A-6 |
| | 10036 | Unlined Rock Cross Passageway | LF | 9-A-6 |
| | 10039 | Other Cross Passageway | LF | 9-A-6 |
| Interior Walls | 10041 | Concrete Interior Walls | SF | 9-A-7 |
| | 10049 | Other Interior Walls | SF | 9-A-7 |
| Portals | 10051 | Concrete Portal | SF | 9-A-7 |
| | 10055 | Masonry Portal | SF | 9-A-7 |
| | 10059 | Other Portal | SF | 9-A-7 |
| Ceiling Slab | 10061 | Concrete Ceiling Slab | SF | 9-A-8 |
| | 10069 | Other Ceiling Slab | SF | 9-A-8 |
| Ceiling Girder | 10070 | Steel Ceiling Girder | LF | 9-A-8 |
| | 10071 | Concrete Ceiling Girder | LF | 9-A-8 |
| | 10072 | Prestressed Concrete Ceiling Girder | LF | 9-A-8 |
| | 10079 | Other Ceiling Girder | LF | 9-A-8 |
| Hangers and Anchorages | 10080 | Steel Hangers and Anchorages | EA | 9-A-9 |
| | 10089 | Other Hangers and Anchorages | EA | 9-A-9 |
| Ceiling Panels | 10090 | Steel Ceiling Panels | SF | 9-A-9 |
| | 10091 | Concrete Ceiling Panels | SF | 9-A-9 |
| | 10099 | Other Ceiling Panels | SF | 9-A-9 |
| Invert Slab | 10101 | Concrete Invert Slab | SF | 9-A-10 |
| | 10109 | Other Invert Slab | SF | 9-A-10 |

| Element Type | Element Number | Element Description | Unit | Page |
|---|---|---|---|---|
| Slab-on-Grade | 10111 | Concrete Slab-on-Grade | SF | 9-A-10 |
| | 10119 | Other Slab-on-Grade | SF | 9-A-10 |
| Invert Girder | 10120 | Steel Invert Girder | LF | 9-A-11 |
| | 10121 | Concrete Invert Girder | LF | 9-A-11 |
| | 10122 | Prestressed Concrete Invert Girder | LF | 9-A-11 |
| | 10129 | Other Invert Girder | LF | 9-A-11 |
| Joints | 10130 | Strip Seal Expansion Joint | LF | 9-A-11 |
| | 10131 | Pourable Joint Seal | LF | 9-A-11 |
| | 10132 | Compression Joint Seal | LF | 9-A-11 |
| | 10133 | Assembly Joint With Seal | LF | 9-A-11 |
| | 10134 | Open Expansion Joint | LF | 9-A-11 |
| | 10135 | Assembly Joint Without Seal | LF | 9-A-11 |
| | 10139 | Other Joint | LF | 9-A-12 |
| Gaskets | 10140 | Gaskets | LF | 9-A-12 |
| Wearing Surface | 10151 | Concrete Wearing Surface | SF | 9-A-13 |
| | 10158 | Asphalt Wearing Surface | SF | 9-A-13 |
| | 10159 | Other Wearing Surface | SF | 9-A-13 |
| Traffic Barrier<br>Pedestrian Railing | 10160 | Steel Traffic Barrier | LF | 9-A-14 |
| | 10161 | Concrete Traffic Barrier | LF | 9-A-14 |
| | 10169 | Other Traffic Barrier | LF | 9-A-14 |
| | 10170 | Steel Pedestrian Railing | LF | 9-A-14 |
| | 10171 | Concrete Pedestrian Railing | LF | 9-A-14 |
| | 10179 | Other Pedestrian Railing | LF | 9-A-14 |
| Lighting Fixtures | 10601 | Tunnel Lighting Fixtures | EA | 9-A-15 |
| Protective Systems | 10952 | Fire Protective Coating | SF | 9-A-15 |
| | 10955 | Reflective Tunnel Tile | SF | 9-A-16 |

Tunnel liner quantities are based on the shape of the liner perimeter which does not include the roadway because the roadway/slab elements document these conditions. The total quantity for circular tunnel shape has a circular perimeter multiplied by the length of tunnel. The total quantity for a horseshoe tunnel is the perimeter exposed to traffic minus the roadway surface multiplied by the length of tunnel.

### 10000 Steel Tunnel Liner — Units – SF

Record this element for all steel tunnel liners. Steel tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

### 10001 Cast-in-Place Concrete Tunnel Liner — Units – SF

Record this element for all cast-in-place concrete tunnel liners. Cast-in place concrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

### 10002 Precast Concrete Tunnel Liner — Units – SF

Record this element for all precast concrete tunnel liners. Precast concrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

### 10003 Shotcrete Tunnel Liner — Units – SF

Record this element for all shotcrete tunnel liners. Shotcrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

### 10004 Timber Tunnel Liner — Units – SF

Record this element for all timber tunnel liners consisting of timber sets with or without timber lagging. Timber tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

## 10005 Masonry Tunnel Liner Units – SF

Record this element for all masonry tunnel liners. Masonry tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

## 10006 Unlined Rock Tunnel Units – SF

Record this element for all unlined rock tunnels. Unlined rock tunnels function as the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of an unlined rock tunnel is the product of the length of the tunnel (along the centerline) and the perimeter of the unlined rock.

**Condition States for WSDOT Elements 10000, 10002, 10003, 10004, 10005, and 10006**

1. Defects are superficial and have no effect on the structural capacity of the tunnel.
2. Tunnel Liner area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Tunnel Liner area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Tunnel area affected by damage in locations or quantity and has reduced the structural capacity of the tunnel (or tunnel liner). Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## 10007 Rock Bolt/Dowel Units – EA

Record this element for all rock bolts or dowels and is not a tunnel liner element. This documents all rock or soil nails used to stabilize the earth in the tunnel, or at and above the portals. Dowels used to connect pieces of precast concrete tunnel liner are considered part of the tunnel liner element and not included in this element.

The total number of rock bolt/dowels is the sum of all the number of rock bolts and dowels.

1. Defects are superficial and have no effect on the structural capacity of the tunnel.
2. Number of bolts with repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Number of bolts with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Number of bolts affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

| 10009 | Other Tunnel Liner | Units – SF |
|---|---|---|

Record this element for all tunnel liners composed of other materials. Other tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

1. Defects are superficial and have no effect on the structural capacity of the tunnel.
2. Tunnel Liner area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Tunnel Liner area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Tunnel area affected by damage in locations or quantity and has reduced the structural capacity of the tunnel (or tunnel liner). Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

| 10010 | Steel Tunnel Roof Girders | Units – LF |
|---|---|---|

| 10011 | Concrete Tunnel Roof Girders | Units – LF |
|---|---|---|

| 10012 | Prestressed Concrete Tunnel Roof Girders | Units – LF |
|---|---|---|

| 10019 | Other Tunnel Roof Girders | Units – LF |
|---|---|---|

**Condition States for WSDOT Elements 10010, 10011, 10012, 10019**

1. Defects are superficial and have no effect on the structural capacity.
2. Girder length affected by patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Girder length affected by defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Girder span length affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Column/Piles

| | | |
|---|---|---|
| **10020** | **Steel Columns/Piles** | **Units – EA** |
| **10021** | **Concrete Columns/Piles** | **Units – EA** |
| **10029** | **Other Columns/Piles** | **Units – EA** |

1. Defects are superficial and have no effect on the structural capacity of the element. There may be discoloration, efflorescence, and/or superficial cracking, spalls, or delaminations.
2. Number of pile/columns that has been repaired or patched.
3. Number of pile/columns has structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs. Structural deficiencies are not limited to delaminations, spalls, structural cracking, exposed or corroded reinforcing or strands.
4. Number of pile/columns with damage in locations or quantity and has reduced the structural capacity of the element or the bridge. Structural analysis is warranted

## Tunnel Passageway

| | | |
|---|---|---|
| **10030** | **Steel Cross Passageway** | **Units – LF** |
| **10031** | **Concrete Cross Passageway** | **Units – LF** |
| **10033** | **Shotcrete Cross Passageway** | **Units – LF** |
| **10034** | **Timber Cross Passageway** | **Units – LF** |
| **10035** | **Masonry Cross Passageway** | **Units – LF** |
| **10036** | **Unlined/Rock Cross Passageway** | **Units – LF** |
| **10039** | **Other Cross Passageway** | **Units – LF** |

**Condition States for WSDOT Elements 10030, 10031, 10033, 10034, 10035, 10036, and 10039**

1. Defects are superficial and have no effect on the structural capacity.
2. Passageway length affected by patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Passageway length affected by defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Passageway length affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Interior Walls

| 10041 | Concrete Interior Walls | Units – SF |
|---|---|---|

| 10049 | Other Interior Walls | Units – SF |
|---|---|---|

**Condition States for WSDOT Elements 10041 and 10049**

1. Defects are superficial and have no effect on the structural capacity.
2. Wall Area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Wall Area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Wall Area affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Portal

| 10051 | Concrete Portal | Units – SF |
|---|---|---|

| 10055 | Masonry Portal | Units – SF |
|---|---|---|

| 10059 | Other Portal | Units – SF |
|---|---|---|

**Condition States for WSDOT Elements 10051, 10055, and 10059**

1. Defects are superficial and have no effect on the structural capacity.
2. Portal Area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Portal Area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Portal Area affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Ceiling Slab

| | | |
|---|---|---|
| **10061** | **Concrete Ceiling Slab** | **Units – SF** |
| **10069** | **Other Ceiling Slab** | **Units – SF** |

**Condition States for WSDOT Elements 10061 and 10069**

1. Defects are superficial and have no effect on the structural capacity.
2. Ceiling Slab Area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Ceiling Slab Area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Ceiling Slab Area affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Ceiling Girder

| | | |
|---|---|---|
| **10070** | **Steel Ceiling Girder** | **Units – LF** |
| **10071** | **Concrete Ceiling Girder** | **Units – LF** |
| **10072** | **Prestressed Concrete Ceiling Girder** | **Units – LF** |
| **10079** | **Other Ceiling Girder** | **Units – LF** |

**Condition States for WSDOT Elements 10070, 10071, 10072, and 10079**

1. Defects are superficial and have no effect on the structural capacity.
2. Ceiling Girder length affected by patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Ceiling Girder length affected by defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Ceiling Girder span length affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Hangers/Anchors

| 10080 | Steel Hangers and Anchorages | Units – EA |
|---|---|---|

| 10089 | Other Hangers and Anchorages | Units – EA |
|---|---|---|

**Condition States for WSDOT Elements 10080, and 10089**

1. Defects are superficial and have no effect on the structural capacity of the element. There may be discoloration, corrosion, efflorescence, and/or superficial cracking, spalls, or delaminations.
2. Number of Hanger/Anchors that have been repaired or patched.
3. Number of Hanger/Anchors with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs. Structural deficiencies are not limited to delaminations, spalls, structural cracking, corrosion, deformity, exposed or corroded reinforcing or strands.
4. Number of Hanger/Anchors with damage in locations or quantity and has reduced the structural capacity of the element or the supported portion of the structure. Structural analysis is warranted.

## Tunnel Ceiling Panels

| 10090 | Steel Ceiling Panels | Units – SF |
|---|---|---|

| 10091 | Concrete Ceiling Panels | Units – SF |
|---|---|---|

| 10099 | Other Ceiling Panels | Units – SF |
|---|---|---|

**Condition States for WSDOT Elements 10090, 10091, and 10099**

1. Defects are superficial and have no effect on the structural capacity.
2. Ceiling Panel Area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Ceiling Panel Area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Ceiling Panel Area affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Invert Slab

| 10101 | Concrete Invert Slab | Units – SF |
|---|---|---|

| 10109 | Other Invert Slab | Units – SF |
|---|---|---|

**Condition States for WSDOT Elements 10101 and 10109**

1. Defects are superficial and have no effect on the structural capacity.
2. Invert Slab Area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Invert Slab Area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Invert Slab Area affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Slab on Grade

| 10111 | Concrete Slab on Grade | Units – SF |
|---|---|---|

| 10119 | Other Slab on Grade | Units – SF |
|---|---|---|

**Condition States for WSDOT Elements 10111 and 10119**

1. Defects are superficial and have no effect on the structural capacity.
2. Slab On Grade Area with patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Slab On Grade Area with structural defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Slab On Grade Area affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Invert Girder

| | | |
|---|---|---|
| **10120** | **Steel Invert Girder** | **Units – LF** |
| **10121** | **Concrete Invert Girder** | **Units – LF** |
| **10122** | **Prestressed Concrete Invert Girder** | **Units – LF** |
| **10129** | **Other Invert Girder** | **Units – LF** |

**Condition States for WSDOT Elements 10120, 10121, 10122, and 10129**

1. Defects are superficial and have no effect on the structural capacity.
2. Invert Girder length affected by patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Invert Girder length affected by defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Invert Girder span length affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Joints

| | | |
|---|---|---|
| **10130** | **Tunnel Strip Seal Joint** | **Units – LF** |
| **10131** | **Tunnel Pourable Joint Seal** | **Units – LF** |
| **10132** | **Tunnel Compression Seal** | **Units – LF** |
| **10133** | **Tunnel Assembly Joint w/ Seal** | **Units – LF** |
| **10134** | **Tunnel Open Expansion Joint** | **Units – LF** |
| **10135** | **Tunnel Assembly Joint without Seal** | **Units – LF** |

## 10139 Other Tunnel Joint Units – LF

**Condition States for WSDOT Elements 10130, 10131, 10132, 10133, 10134, and 10135.**

These joints use the same philosophy as the 400 series WSDOT Joint elements.

1. The expansion joint is functioning as designed. Joint may not be perfect with signs of leakage. The adjacent slab or header is sound.
2. Skewed joint length at each location with “D” spalls or patches present in the header or in the deck within one foot either side of the joint.
3. Skewed joint length at each location where the deck or headers must be rebuilt to maintain a reliable roadway surface or to maintain seal placement. As a guideline, more than 25 percent of the joint length has spalls or patches in the deck or headers adjacent to the seal.

   Steel Materials: Steel components are banging, cracked, loose, broken, or missing. Steel sections that have been removed and/or replaced with something else (usually concrete patching) should be CS3.

## 10140 Gaskets Units – LF

These joints are design to prevent water from penetrating a tunnel liner such as the seal between a segmental tunnel liner. The condition states focus on leakage and other SNTI defects such as header conditions should be ignored.

1. The expansion joint is functioning as designed. Joint may not be perfect, but the joint is not leaking. Seal may be damaged, worn, or cracked. There may be defects in the joint materials holding the seal in place.
2. Skewed joint length at each location with minor leakage or dripping is present. Signs of leakage may be present where leakage may be intermittent or not leaking at the time of inspection.
3. Skewed joint length at each location where water is free flowing; a threat to the tunnel or a tunnel system.

# Tunnel Wearing Surface

## 10151 Concrete Wearing Surface Units– SF

This element defines a roadway surface made of Portland Cement Concrete Pavement (PCCP). The condition states do not address faulting, cracking, or smoothness of the profile at this time, but these defects should be described in the element notes. The quantity should equal the overlay's width times the length.

1. Defects are superficial. The concrete surface has no spalls/delaminations or previous repairs.
2. Total area of patches.
3. Total area of spalls or potholes.

## 10158 Asphalt Wearing Surface Units– SF

This element defines a roadway surface made of Asphalt Concrete Pavement (ACP), Hot Mixed Asphalt (HMA), or covered with a Bituminous Surface Treatment (BST) which is also called a Chip Seal. The condition states do not address faulting, cracking, or smoothness of the profile at this time. The quantity should equal the overlay's width times the length.

1. Defects are superficial. The asphalt surface has no spalls/delaminations or previous repairs.
2. Total area of patches.
3. Total area of spalls or potholes.

## 10159 Other Wearing Surface Units– SF

This tunnel element defines a roadway surface, or top layer, that is not asphalt or concrete such as a polyester, epoxy, or cementitious overlay on the roadway. The quantity should equal the overlay's width times the length.

1. Defects are superficial. The asphalt surface has no spalls/delaminations or previous repairs.
2. Total area of patches.
3. Total area of spalls or potholes.

## Tunnel Traffic Barrier

| | | |
|---|---|---|
| **10160** | **Steel Traffic Barrier** | **Units – LF** |
| **10161** | **Concrete Traffic Barrier** | **Units – LF** |
| **10169** | **Other Traffic Barrier** | **Units – LF** |

**Condition States for WSDOT Elements 10160, 10161, and 10169**

1. Defects are superficial and have no effect on the structural capacity.
2. Traffic Barrier length affected by patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Traffic Barrier length affected by defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Traffic Barrier length affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Pedestrian Barrier

| | | |
|---|---|---|
| **10170** | **Steel Pedestrian Railing** | **Units – LF** |
| **10171** | **Concrete Pedestrian Railing** | **Units – LF** |
| **10179** | **Other Pedestrian Railing** | **Units – LF** |

**Condition States for WSDOT Elements 10170, 10171, and 10179**

1. Defects are superficial and have no effect on the structural capacity.
2. Pedestrian Railing length affected by patches, repairs, or other type of mitigation for a CS3 or CS4 defect.
3. Pedestrian Railing length affected by defects. The defects do not significantly affect structural capacity. Deficiencies do not warrant analysis, but may require repairs.
4. Pedestrian Railing length affected by damage in locations or quantity and has reduced the structural capacity of the element. Structural analysis is warranted or has determined repairs are essential to restore the full capacity of the element. Defects threaten public safety, or the primary design function of the element.

## Tunnel Mechanical systems (blank)

## Tunnel Electrical Systems

**10601 Tunnel Lighting Fixtures** **Units – EA**

Record this element for all tunnel lighting fixtures. This element includes the physical housing of the tunnel lights and their connections to the support, but does not include the blub. When a lighting fixture serves the dual purpose of general tunnel lighting and emergency tunnel lighting, it is only counted under the tunnel lighting fixture element. However, those fixtures will have an impact on both tunnel lighting system and emergency lighting system elements.

The total quantity for tunnel lighting fixture is the sum of all the tunnel lighting fixtures.

1. Tunnel lighting fixture is fully effective and is functioning as designed. The housing is sealed and protecting the wiring. The anchors are installed and functioning properly.
2. Number of tunnel lighting fixtures that have been repaired.
3. Number of tunnel lighting fixtures with defects. The defects do not significantly affect the ability of the fixture to perform as designed but may require a repair. Weak connections do not threaten public.
4. Number of tunnel lighting fixtures with damage. The defects affect the ability of the fixture to perform as designed but and require repair or replacement. Weak connections threaten the public if they fail.

## Fire/Life Safety/Security Systems

**10952 Fire Protective Coating** **Units – SF**

Record this element for all fire protective coatings used in the tunnel. This element is the coating applied on the tunnel elements to protect these elements from fire.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

1. Fire protective coating is fully effective and will function as designed in a fire.
2. Fire protective coating area that has been repaired.
3. Fire protective coating area that is substantially or has limited effectiveness to protect the underlying material in a fire.
4. Fire protective coating area that has exposed the underlying material.

## Tunnel Signs (blank)

## Tunnel Protective Coatings

**10955 Reflective Tunnel Tile** **Units – SF**

This element identifies tunnel tile attached to a tunnel liner whether it is reflective or not. The total quantity is the area of tile visible for inspection.

1. Tile is bonded with no cracks, chips, or blemishes. Tile may be dirty but reflectivity is enhanced during regular tunnel washing operations.
2. Tile area that has been repaired.
3. Tile area that is bonded, but cracked and may have efflorescence or small amounts of section loss. Tile may be blemished from impact or other causes resulting in major loss of reflectivity.
4. Tile area with delaminations based on soundings, is completely missing, or has major section loss warranting replacement.

# *Appendix 9-B* *Vacant*

# Appendix 9-C WSDOT/NTI Tunnel Inventory Codes

| WSBIS | NTI Item ID | NTI Inventory Item Name | Comments |
|---|---|---|---|
| 1001 | I.1 | Tunnel Number | |
| 1132 | I.2 | Tunnel Name | |
| n/a | I.3 | State Code | autogenerated for the NTI submittal |
| 1021 | I.4 | County Code | |
| 1276 | I.5 | Place Code | |
| 1274 | I.6 | Highway Agency District | |
| 1435 | I.7 | Route Number | |
| 1436 | I.8 | Route Direction | |
| 1433 | I.9 | Route Type | |
| 1256 | I.10 | Facility Carried | |
| 1467 | I.11 | LRS Route ID | |
| 1469 | I.12 | LRS Mile Point | |
| 1188 | I.13 | Tunnel Portal's Latitude | |
| 1196 | I.14 | Tunnel Portal's Longitude | |
| n/a | I.15 | Border Tunnel State or Country Code | Washington State has no border tunnels, autogenerated for NTI submittal |
| n/a | I.16 | Border Tunnel Financial Responsibility | Washington State has no border tunnels, autogenerated for NTI submittal |
| n/a | I.17 | Border Tunnel Number | Washington State has no border tunnels, autogenerated for NTI submittal |
| n/a | I.18 | Border Tunnel Inspection Responsibility | Washington State has no border tunnels, autogenerated for NTI submittal |
| 1332 | A.1 | Year Built | |
| 1336 | A.2 | Year Rehabilitated | |
| 1354 | A.3 | Total Number of Lanes | |
| 1445 | A.4 | Average Daily Traffic | |
| 1451 | A.5 | Average Daily Truck Traffic | |
| 1453 | A.6 | Year of Average Daily Traffic | |
| 1413 | A.7 | Detour Length | |
| 1543 | A.8 | Service in Tunnel | |
| 1019 | C.1 | Owner | |
| 1286 | C.2 | Operator | |
| 1490 | C.3 | Direction of Traffic | |
| 1285 | C.4 | Toll | |
| 1483 | C.5 | NHS Designation | |
| 1485 | C.6 | STRAHNET Designation | |
| 1487 | C.7 | Functional Classification | |
| 1022 | C.8 | Urban Code | |
| 1349 | G.1 | Tunnel Length | |
| 1401 | G.2 | Minimum Vertical Clearance over Tunnel Roadway | |
| 1356 | G.3 | Roadway Width, Curb-to-Curb | |
| 1364 | G.4 | Left Sidewalk Width | |
| 1367 | G.5 | Right Sidewalk Width | |

| WSBIS | NTI Item ID | NTI Inventory Item Name | Comments |
|---|---|---|---|
| 1992 | D.1 | Routine Inspection Target Date | |
| n/a | D.2 | Actual Routine Inspection Date | Inspection dates for routine report type will be reported to the NTI. |
| n/a | D.3 | Routine Inspection Interval | Inspection frequencies for routine report type will be reported to the NTI. |
| n/a | D.4 | In-Depth Inspection | Structures with this report type will be flagged as such in the NTI submittal. |
| n/a | D.5 | Damage Inspection | Structures with this report type will be flagged as such in the NTI submittal. |
| n/a | D.6 | Special Inspection | Structures with this report type will be flagged as such in the NTI submittal. |
| 1554 | L.1 | Load Rating Method | |
| 1556 | L.2 | Inventory Load Rating Factor | |
| 1553 | L.3 | Operating Load Rating Factor | |
| 1293 | L.4 | Tunnel Load Posting Status | |
| 1560 | L.5 | Posting Load – Gross | |
| 1561 | L.6 | Posting Load – Axle | |
| 1562 | L.7 | Posting Load – Type 3 | |
| 1563 | L.8 | Posting Load – Type 3S2 | |
| 1564 | L.9 | Posting Load – Type 3-3 | |
| 1402 | L.10 | Height Restriction | |
| 1408 | L.11 | Hazardous Material Restriction | |
| 1409 | L.12 | Other Restrictions | |
| n/a | N.1 | Under Navigable Waterway | Washington state has no tunnels under waterways, autogenerated for the NTI submittal. |
| n/a | N.2 | Navigable Waterway Clearance | Washington state has no tunnels under waterways, autogenerated for the NTI submittal. |
| n/a | N.3 | Tunnel or Portal Island Protection from Navigation | Washington state has no tunnels under waterways, autogenerated for the NTI submittal. |
| 1510 | S.1 | Number of Bores | |
| 1511 | S.2 | Tunnel Shape | |
| 1512 | S.3 | Portal Shapes | |
| 1513 | S.4 | Ground Conditions | |
| 1514 | S.5 | Complex | |